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Seventh Annual Energy Report:

CLEAN ENERGY OPPORTUNITIES AND DIRTY ENERGY CHALLENGES

By Amanda Levin









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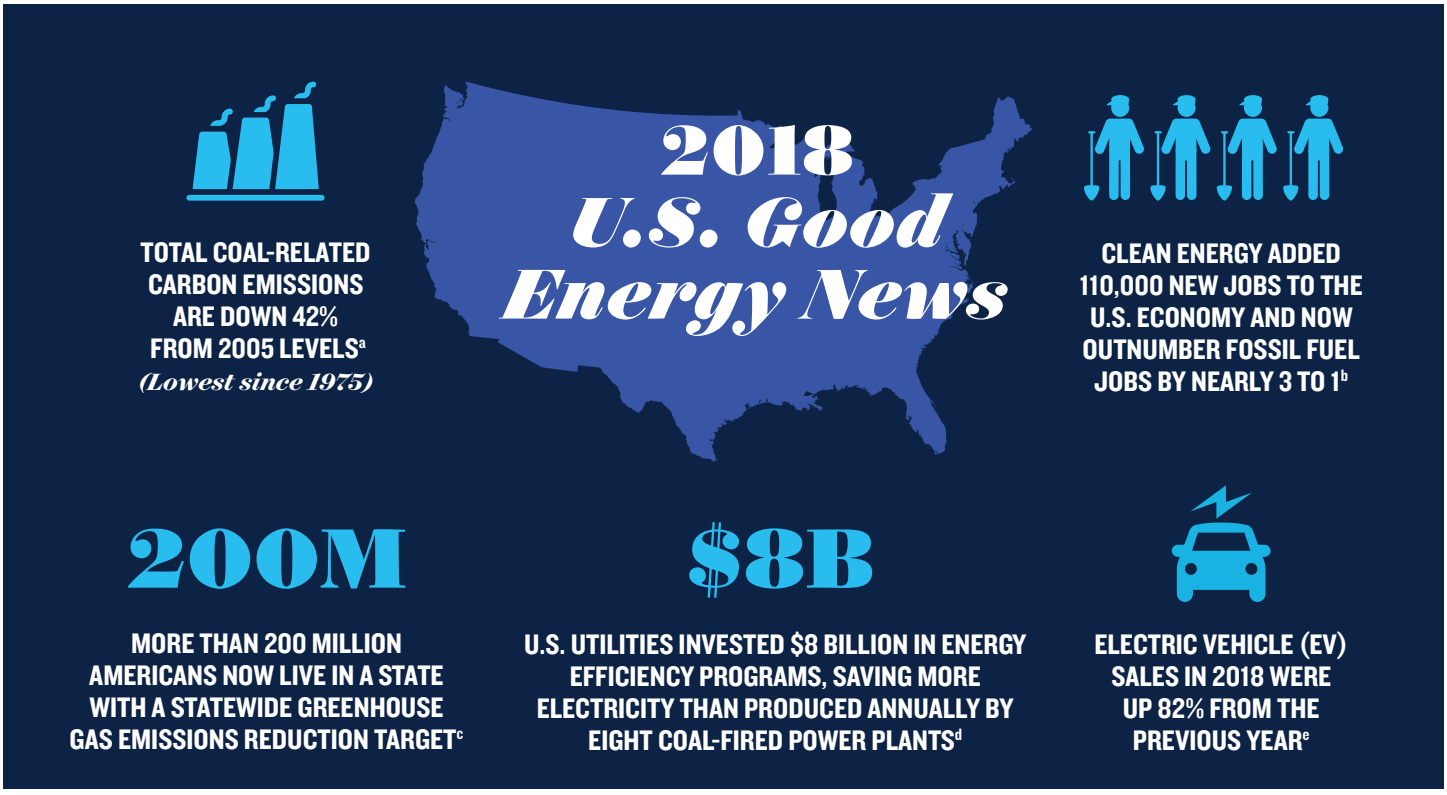
INTRODUCTION

The U.S. energy sector has entered a new phase in the energy transition. Although there is still much left to do, we are making real progress in many clean energy arenas. Solar and wind energy are thriving, and the technologies to help smooth out the highs and lows of renewable energy generation and integrate these clean resources into the electric grid are becoming commercial realities. The costs of clean energy continue to fall rapidly. Wind and solar already outcompete coal power and are likely to put similar economic pressure on natural gas within the next decade and a half. Meanwhile, coal-fired generation has sunk to a four-decade low. In fact, coal consumption economy-wide in 2018 was 47 percent lower than the Department of Energy (DOE) projected it would be a decade ago, while wind and solar power capacity in 2018 was four times higher than DOE anticipated. But at the same time, natural gas and oil infrastructure is expanding, incentivized by the influx of cheap fracked oil and gas. This threatens to undermine climate progress in the U.S. by locking in the use of climate-warming fossil fuels.



a U.S. Energy Information Administration (hereinafter EIA), *Electric Power Monthly*, https://www.eia.gov/electricity/monthly (accessed August 9, 2019).

b E2, *Clean Jobs America* 2019, March 13, 2019, https://www.e2.org/reports/clean-jobs-america-2019.

c U.S. Climate Alliance, "Governors," https://www.usclimatealliance.org/governors-1 (accessed August 9, 2019). Center for Climate and Energy Solutions, "U.S. State Greenhouse Gas Emissions Targets," https://www.c2es.org/document/greenhouse-gas-emissions-targets (accessed August 9, 2019). U.S. Census Bureau, *2018 National and State Population Estimates*, December 19, 2018, https://www.census.gov/newsroom/press-kits/2018/pop-estimates-national-state.html. Includes District of Columbia and Puerto Rico.

d Weston Berg et al., *2019 State Energy Efficiency Scorecard*, American Council for an Energy-Efficient Economy (hereinafter ACEEE), October 1, 2019, https://aceee.org/research-report/u1908.

e Steven Loveday, "December 2018 U.S. Plug-In EV Sales Report Card," *InsideEVs*, January 5, 2019, https://insideevs.com/news/341824/december-2018-us-plug-in-ev-sales-report-card.

The Intergovernmental Panel on Climate Change (IPCC) in the fall of 2018 called on the global community to limit warming to 1.5 degrees Celsius to avoid the most catastrophic and irreversible effects of climate change.[1] The United States and the rest of the world are already experiencing the impacts of a warming world: extreme heat waves in 2018 and 2019 that strained energy systems, unprecedented ice loss, more frequent and intense storms, and record flooding that hit America's farm belt especially hard.[2] As more people see these impacts in their own lives or in the lives of their loved ones, public awareness and concern over climate change has grown.[3]

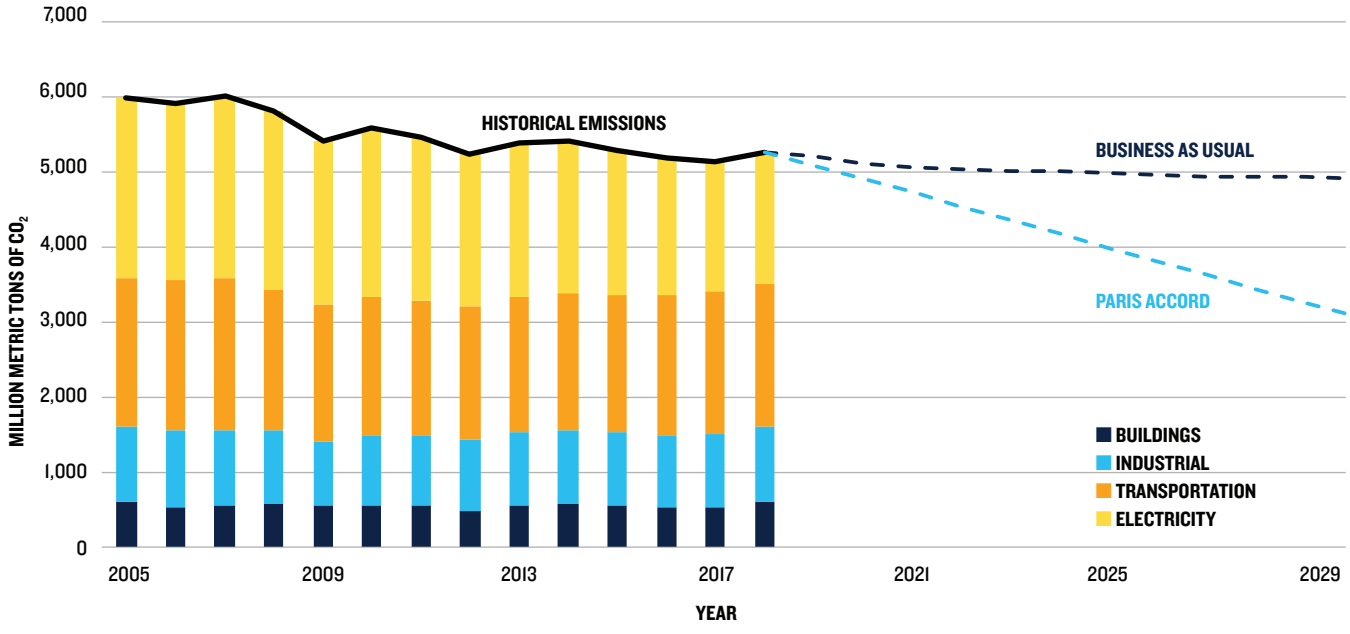
The financial and environmental costs of inaction have become increasingly evident, but our current energy policies are insufficient to meet our climate goals. After five years of declining carbon dioxide (CO_2) emissions, U.S. emissions ticked up in 2018 and globally, CO_2 emissions hit an all-time high.[4] The Trump administration's ongoing efforts to repeal important energy- and emissions-saving regulations while promoting policies to drill for fossil fuels first will only further hamper the ability of the United States to cut climate pollution at the pace necessary to avert the worst impacts of the climate crisis.

Despite stalled (and sometimes backward) momentum at the national level, we also saw groundbreaking commitments from states, cities, utilities, and businesses to rise to the climate challenge. Six states—plus Washington, D.C., and Puerto Rico—and nine large utilities are now committed to 100 percent carbon-free power by 2050 or earlier. This means that more than 44.5 million U.S. homes and businesses are now located in a state or utility service area that is committed to 100 percent clean energy. Twenty-five states have carbon or greenhouse gas (GHG) emissions-reduction targets. Since the end of 2017, nine states have strengthened their economy-wide targets to cut climate pollution. In addition, more than 400 American cities have individually committed to the emissions-reduction goals of the Paris Accord since 2017.[5] Thus far, these cities have taken more than 250 major actions to support more energy-efficient buildings and transportation. More than 110 U.S. cities have also adopted 100 percent clean electricity goals.[6] Business is moving forward as well: Almost a quarter of the Fortune 500 companies are involved in at least one major climate initiative, such as the Science-Based Target Initiative. An additional 565 businesses have adopted or committed to adopting GHG emissions-reduction targets, and more than 150 other businesses have pledged to transition to 100 percent renewable power. Together, these commitments and actions can drive significant changes in the U.S. energy system and lead the charge into a safer, cleaner climate future.

GREENHOUSE GASES

Unfortunately, overall levels of climate-warming emissions rose in this country in 2018, for the first time in five years. Carbon dioxide accounts for most U.S. GHG emissions, followed by methane, nitrous oxide, and fluorinated gases.[7] National power sector emissions rose by 1.4 percent relative to 2017 levels, an increase of 20 million metric tons (about equal to the yearly emissions from five coal plants). Total energy-related U.S. emissions (not only from electricity but from fossil fuel–powered vehicles, natural gas home heating, and other uses) rose by 2.8 percent compared with 2017; that means we produced an extra 138 million metric tons of emissions, equivalent to the yearly pollution from 30 million cars.[8] However, despite the increase in 2018, emissions economy-wide are still 12 percent lower than in 2005.

FIGURE 1: HISTORICAL AND PROJECTED CARBON EMISSIONS IN THE UNITED STATES



The emissions reductions achieved over the previous five years were already much smaller than what is needed to avert the severest effects of global warming, and the fact that U.S. emissions actually increased in 2018 bodes even worse for climate progress. Even more worrisome, this was a global trend. Carbon emissions worldwide were estimated at an all-time high in 2018, 2.7 percent above 2017 levels.[9] This is a disconcerting shift away from the plateau in global emissions seen from 2014 through 2016.

News of rising GHG emissions accompanies increasingly dire warnings about the damage climate change will inflict on individuals, the global economy, and natural ecosystems. When the international community came together to address climate change in the 2016 Paris Accord, the signatories agreed to work to limit global warming to less than 2 degrees above preindustrial levels and to pursue efforts wherever possible to keep warming below 1.5°C.[10] The 2018 IPCC report, however, gave new urgency to this lower limit, saying that a failure to meet it would lead to climate impacts that would ultimately result in catastrophic and widespread harm.[11]

Achieving this more ambitious goal will require aggressive action. The IPCC estimates the world needs to cut GHG pollution by 45 percent within the next 11 years (by 2030) to remain on track for 1.5°C, compared with the 20 percent cut required under a 2-degree pathway (see Figure 1). Global GHG pollution will need to fall to net zero by 2050, about 15 years earlier than under a 2-degree scenario.[12] These targets may seem daunting, but they are both feasible and affordable, according to the IPCC. While success will require unprecedented and coordinated action, we have most, if not all, of the tools needed to combat this crisis—like energy efficiency, clean and renewable electricity, and cleaner electric alternatives to gas-guzzling vehicles and gas-heated homes and offices.[13]

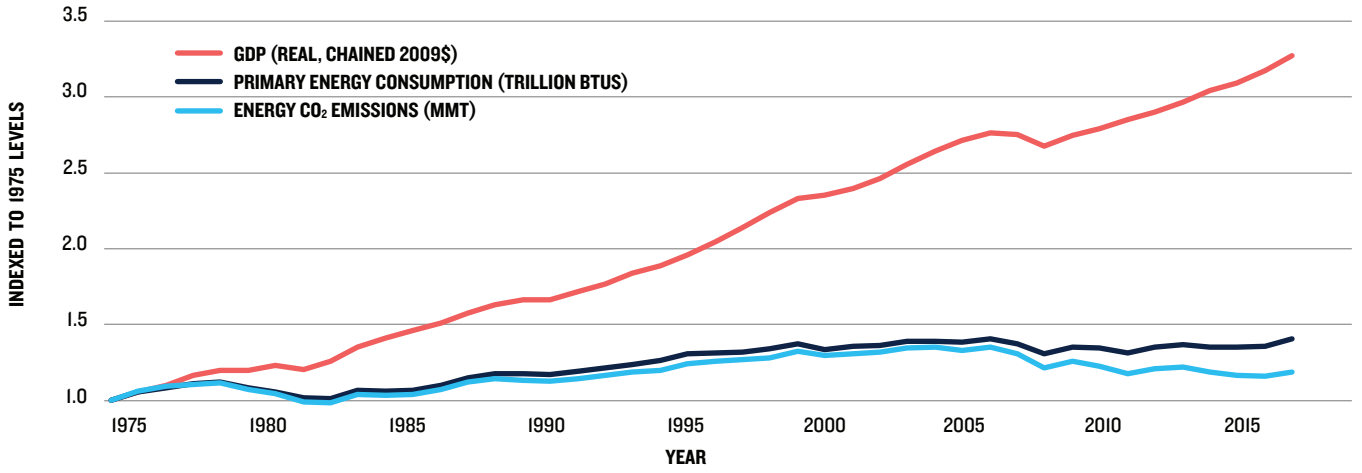
ENERGY EFFICIENCY

In 2018, in the face of federal rollbacks of electricity and appliance standards, cities, states, and utilities embraced energy efficiency, taking advantage of one of the most cost-effective options for reaching their climate targets and decarbonizing the U.S. economy.[14] Efficient systems use less energy, which means less carbon pollution in the atmosphere and lower utility bills for consumers. As shown in Figure 2, energy efficiency improvements have helped energy consumption remain relatively flat over the past 40 years while still powering a thriving U.S. economy. While gross domestic product (GDP) has tripled (in real terms) since 1975, total U.S. energy consumption has grown by only 40 percent since then. Going forward, strong energy efficiency policies and investments alone could achieve more than 40 percent of the emissions reductions needed to reach global climate goals, relying only on the commercially available technologies we have today.[15]

Energy efficiency saves money for everyone, which is especially critical for customers with the highest energy burden (the percentage of household income spent on energy bills).[16] Making energy more affordable ensures that lower-income customers do not have to choose between heating their homes and paying for food. These savings are not trivial: The average U.S. family saves almost $500 in energy and water bills thanks to national appliance efficiency standards already in place.[17] Overall, federal appliance and equipment efficiency standards will save American homes and businesses nearly $2 trillion on utility bills by 2030.[18]

Unfortunately, more needs to be done to protect energy efficiency at the federal level. In sharp contrast with decades of bipartisan efficiency regulation that has reduced households' energy bills, created jobs, improved air quality,

FIGURE 2: ADVANCING ENERGY EFFICIENCY MEANS REDUCING THE ENERGY INTENSITY OF THE U.S. ECONOMY



and cut climate pollution, this past year saw disturbing disruptions of the U.S. DOE's highly successful energy efficiency standards program.[19] For example:

- The DOE proposed new classifications of products that would allow manufacturers to evade efficiency rules, and it put forward a loophole that would let manufacturers conduct their own internal efficiency testing.[20]
- The DOE also proposed reclassifications of natural-gas furnaces and water heaters that would allow inefficient gas appliances to remain on the market.
- Another proposal would change the DOE's Process Rule (which describes the procedures and policies the department should use when establishing or updating efficiency standards), making it harder to set future efficiency standards.
- In addition to delaying energy-saving standards for federal buildings and relaxing light bulb efficiency standards worth $100 in annual savings per household, the DOE missed 18 deadlines to update appliance standards.[21]

Despite these federal setbacks, state and local governments stepped up to advance energy efficiency in 2018. The efficiency industry added 76,000 new jobs last year, more than half of all new energy jobs and the most of any energy sector.[22] By the end of the year, 2.35 million Americans worked in the energy efficiency sector, or about 35 percent of all Americans employed by the energy industry.[23] Clean energy jobs now outnumber those in the fossil fuel industry by 3 to 1, with energy efficiency providing the bulk of all clean energy jobs in America.[24]

California established the nation's first net-zero electricity building code, ensuring that every new single-family home and low-rise apartment building consumes no more electricity than it generates from on-site renewables (like rooftop solar).[25] California also finalized a new standard for spray sprinklers that is one of the most consequential water-saving measures ever implemented by a state. The standard will save an enormous amount of water—more than 400 million gallons *per day* within 10 years—by reducing irrigation misting and overspray, while also saving 543 gigawatt-hours of electricity per year by 2030.[26]

Washington, Colorado, and Hawaii joined states like Vermont in setting energy and water efficiency standards for a range of appliances that will save residents more than $3 billion on their utility bills over the next 15 years.[27] Virginia approved legislation that includes $1 billion of investments in energy efficiency over the next 10 years, while New Jersey and New York both passed stronger energy efficiency savings targets (or Energy Efficiency Resource Standards, EERS), mandating that electric utilities develop efficiency programs to achieve, respectively, 2 percent and 3 percent annual savings (as a percentage of retail sales) within the next few years (see Figure 3).[28] In a win for equitable energy access, the Empire State's Green Jobs–Green New York program also sets aside funds for energy efficiency workforce training and low-cost financing options for efficiency upgrades, which will ensure that local workers are the ones installing these efficiency measures and that all communities can participate in efficiency programs.[29]

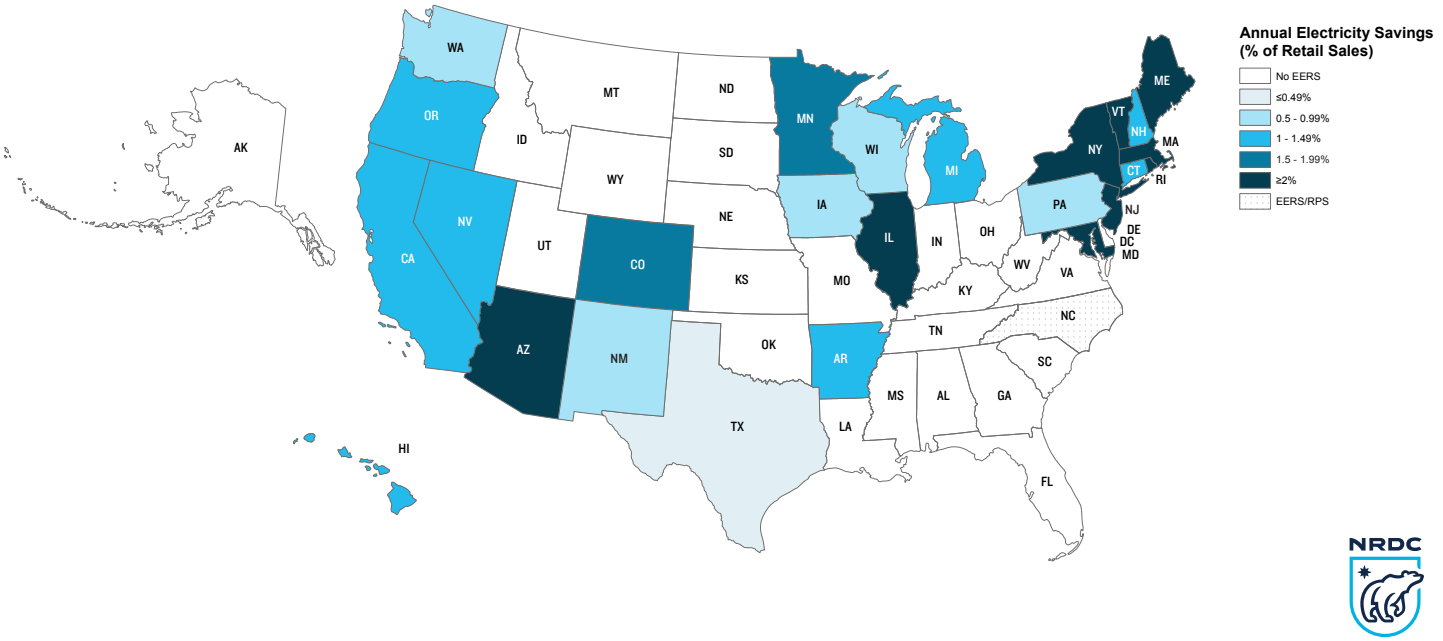
Cities too are rising to the challenge. Since 2017 individual cities have taken more than 250 major actions to advance energy efficiency agendas through building and transportation policies, utility efficiency programs, and community initiatives that account for social equity in energy planning.[30] In 2018, 25 of the largest cities in America joined the American Cities Climate Challenge (or ACCC). These 25 cities are working with technical experts and advisors to develop and pass high-impact climate policies to meet or exceed the United States' 2025 Paris Accord commitment. Of the 75 U.S. cities assessed in the American Council for an Energy-Efficient Economy's *2019 City Clean Energy Scorecard*, two-thirds have set GHG reductions goals (although only 11 are on track to meet those goals). Among the top-performing cities are:

- New York City, which called for large buildings to publicly post their energy performance ratings and undergo periodic retrocommissioning.
- Seattle (an ACCC city), which mandated building tune-ups and energy assessments every five years.
- Washington, D.C. (an ACCC city), which is working to establish a standardized ENERGY STAR® score that will require around half of the city's buildings to significantly improve their energy performance within the next five to ten years.[31]

U.S. utilities are also helping to promote energy efficiency. In 2018, U.S. utilities collectively invested $8 billion in energy efficiency programs—with about $6.6 billion invested in electricity efficiency programs and another $1.4 billion in natural gas efficiency programs.[32] Nationwide, electric efficiency programs saved enough energy to power every home in Massachusetts, New Hampshire, and Vermont for an entire year.[33] Last year, several utilities ramped up their efficiency efforts:

- Ameren Missouri launched the largest energy efficiency plan in the state's history, announcing more than $200 million in energy efficiency investments to be made over the next four to six years. For qualifying families, Ameren earmarked $50 million for longer-term efficiency solutions that are often beyond the budgets of limited-income families, like new insulation and replacement air-conditioning units.[34]
- In Minnesota, Xcel agreed to reduce electricity demand by 830 megawatts (MW) through demand response and efficiency programs to help replace the generation of two coal plants slated to retire in the next decade.[35] In 2018 Xcel achieved record-setting energy savings of 2.35 percent of retail sales. As part of its long-term resource plan, the utility committed to exceeding this mark every year until 2030.[36]

FIGURE 3: MAP OF STATE ENERGY EFFICIENCY RESOURCE STANDARDS (EERS)



The Massachusetts Department of Public Utilities approved a landmark three-year energy efficiency plan to support the state's new Clean Peak Standard, which tasks utilities with increasing the use of energy from renewable sources during periods when electricity demand on the grid is at its highest, usually due to a large number of customers heating or cooling their homes at the same time. The new energy efficiency plan would reduce peak demand through such measures as compensating customers for allowing their air-conditioning to be automatically set back during high-use periods, preventing the need to fire up fossil fuel plants for only a few hours to meet customer demand and reinforcing grid reliability. The state estimates that the new plan will save Massachusetts customers $8.5 billion on their energy bills.[37]

Because utility revenues are traditionally tied directly to electricity sales, increasing energy efficiency (and thus reducing sales) can result in utilities being unable to recover their costs to serve customers. Policy mechanisms like revenue decoupling are needed to make energy efficiency as attractive an investment as building a new power plant or transmission line. Such mechanisms remove the disincentive to reduce grid electricity sales by breaking the link between utilities' financial health and their customers' energy use. As of 2018, 32 states had active revenue decoupling mechanisms for their gas and/or electric utilities, and six of those states had deployed or were close to deploying performance-based ratemaking options as well.[38]

ELECTRIFYING TRANSPORTATION

The transportation sector is the leading source of GHG emissions in the United States.[39] It also has some of the most challenging barriers to economy-wide decarbonization and will require significant investments in vehicle electrification and new charging infrastructure, cost reductions in battery technologies, and reimagined commercial and public transit systems. In the meantime, national fuel economy and vehicle emissions standards are important first steps: They help shrink the carbon footprint of driving, save Americans money at the pump, reduce the nation's dependence on oil, and set a level playing field for fair competition among automakers to invest in innovation. Unfortunately, the Trump administration is attempting to derail them. In 2018 the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) released a proposal to freeze national fuel economy standards and block states like California from setting their own, more aggressive rules.[40] In a step further, they announced their intention to lower penalties for carmakers violating the fuel efficiency standards already in place. The Trump administration's proposed federal rule would push 60,000 jobs out of the automotive sector, forfeit $6,000 in savings per car owner, and increase dangerous air pollution.[41] States and industry alike have fought this attempt to prolong our dependence on oil; in fact, four major automakers (Ford, Volkswagen, Honda, and BMW) voluntarily agreed in August 2019 to follow a modified version of California's *stricter* fuel economy standards.[42]

Despite these setbacks, the sector is embracing electrification. Electric vehicle (EV) and hybrid sales in 2018 were up 82 percent from the previous year. As shown in Figure 4, EVs are projected to make up more than half of all passenger vehicle sales in less than two decades.[43] The used-car shopping site Shift, where customers can buy affordable used EVs, reported that hybrids and EVs constituted 20 percent of its sales in the past year.[44] The carsharing company Turo reports customer demand for EVs is growing 1.5 times faster than demand for gasoline vehicles; in 2018 three of the top 11 most frequently booked models on the Turo app were EVs.[45]

Public transportation is also opening new avenues for electrification. Many U.S. cities are purchasing electric buses that will both help curb diesel emissions—which contribute to local smog and worsen respiratory issues—and affordably increase access to public transit. The economic and environmental benefits of electrification have sparked interest from private businesses as well. In September 2019, Amazon announced the largest purchase ever (by far) of electric vehicles by a business: 100,000 electric delivery vehicles will be on the streets delivering packages by 2024.[46] UPS has announced that it is ordering electric trucks from manufacturers including Tesla, Workhorse, and Thor and rolling out battery-assisted bicycles for UPS delivery workers in cities.[47] Electric truck motors appeal to delivery and postal service companies not only because of their increased efficiency, which reduces the cost per mile driven, but because their improved torque allows electric trucks to accelerate more quickly, shortening delivery times.

Utilities are eager to understand how widespread EV adoption and integration will affect the grid, curb climate pollution, and lower energy costs for all customers. In 2018 companies such as New York's Con Edison, Arizona's Salt River Power, and the Sacramento Municipal Utility District (SMUD) offered incentives for EV owners to charge during off-peak hours, with SMUD extending free charging for the first two years after the purchase of a new EV.[48] Pacific Gas and Electric Company announced this past year that it would install 7,500 EV chargers at apartment buildings and workplaces across Northern California, adding to the 21,000 charging stations already being used throughout the state.[49] The California Public Utilities Commission ordered that at least 15 percent of these chargers be built in disadvantaged, low-income communities.[50] Kansas City Power & Light's Clean Charge Network just exceeded 1,100 charging stations in parking lots and alleyways.[51] A fleet of other companies, including EVgo, ChargePoint, Tesla, and General Motors, are in the race to build a network of EV chargers across the country in both high-trafficked and rural areas. As of August 2019, California, Texas, New York, and Florida led with the largest publicly available EV charging networks (see Figure 5). And for long-distance all-electric drives, Electrify America promised to increase its network of high-speed charging stations to at least 500 by the end of 2019.[52] Located alongside supermarkets and restaurants, the stations promise to deliver a full vehicle charge in as little as one hour.

FIGURE 4: PROJECTED SALES OF LIGHT-DUTY (PASSENGER) BATTERY ELECTRIC VEHICLES (BEV) AND PLUG-IN HYBRID ELECTRIC VEHICLES (PHEV)

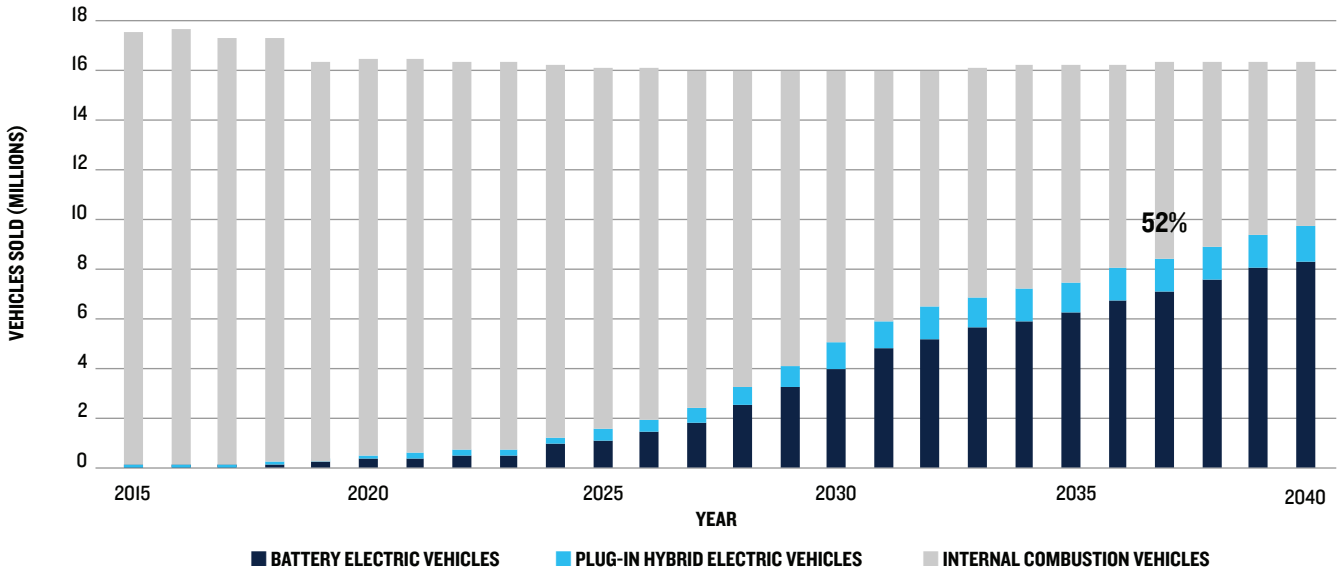
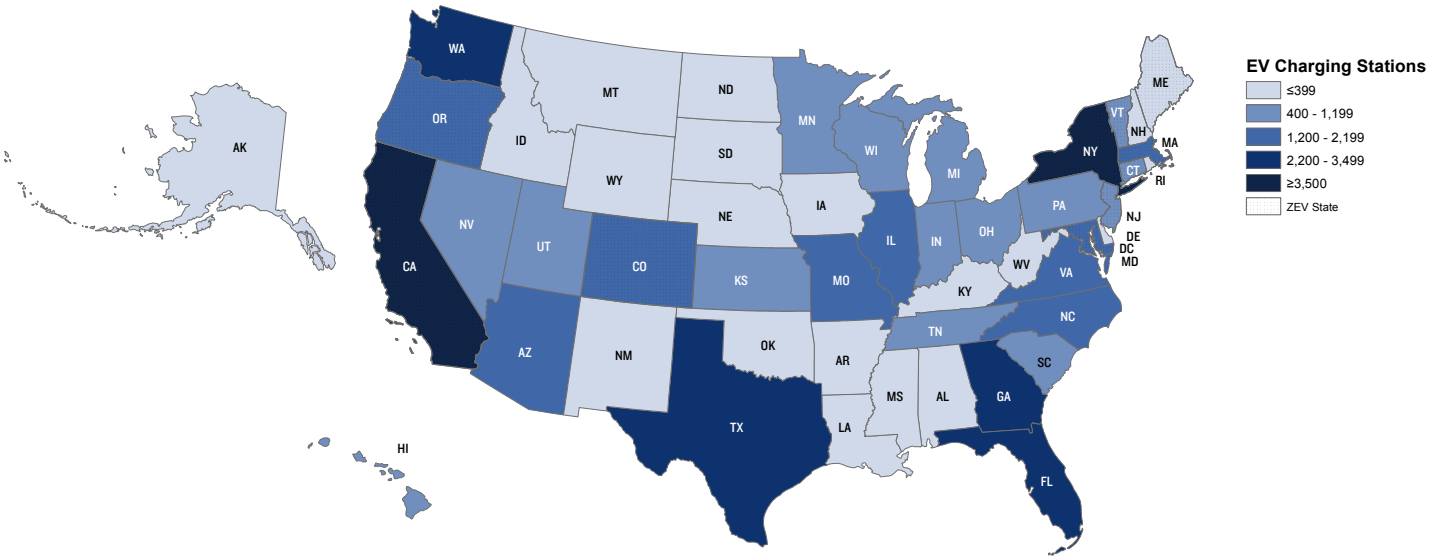


FIGURE 5: PUBLICLY AVAILABLE EV CHARGING STATIONS IN THE U.S. BY STATE AS OF AUGUST 2019[53]



As with energy efficiency, states and cities are fighting federal efforts to weaken transportation standards by cleaning up their own transportation systems. At the end of 2018, nine states and the District of Columbia committed to developing a regional initiative to reduce emissions from the transportation sector and invest in cleaner transportation options and infrastructure. Working together as members of the Transportation and Climate Initiative (TCI), these jurisdictions aim to finalize, by the end of 2019, the policies, emissions goals, and investment strategies that will cut climate pollution from vehicles and deliver low-carbon transportation to communities disproportionately burdened by transit pollution. Also at the end of 2018, California enacted a first-in-the-nation mandate: All new public transit buses must have zero emissions within a decade.[54] California, along with nine other states, also set targets to greatly increase personal electric vehicle sales.[55]

At the city level, New York City set a goal to reach 20 percent EV sales by 2025 and have an all-electric public bus fleet by 2040.[56] Similarly, Chicago is transitioning its bus fleet to 25 percent electric vehicles, with en-route charging stations, in the next six years.[57] Atlanta passed an ordinance requiring all new homes and public parking facilities, including that 20 percent of all new commercial and multifamily parking structures, be "EV ready."[58] Last, using a $50 million grant from the U.S. Department of Transportation's Smart City Challenge, Columbus, Ohio, partnered with 60 local employers to provide workplace EV charging, organized ride-and-drive road shows, and ran EV education workshops for car dealership staff.[59]

RENEWABLE ENERGY

Wind, solar, and geothermal energy represented 9 percent of the U.S. electricity mix in 2018, and hydropower provided another 7 percent.[60] This is a dramatic and exciting increase from the start of the decade, when wind, solar, and geothermal represented just 2.7 percent of the country's electricity mix (see Figure 6).[61]

FIGURE 6: 2018 ELECTRICITY GENERATION MIX

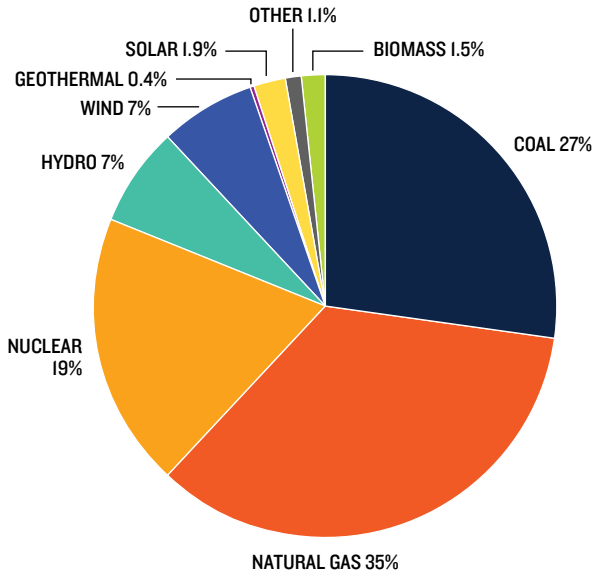
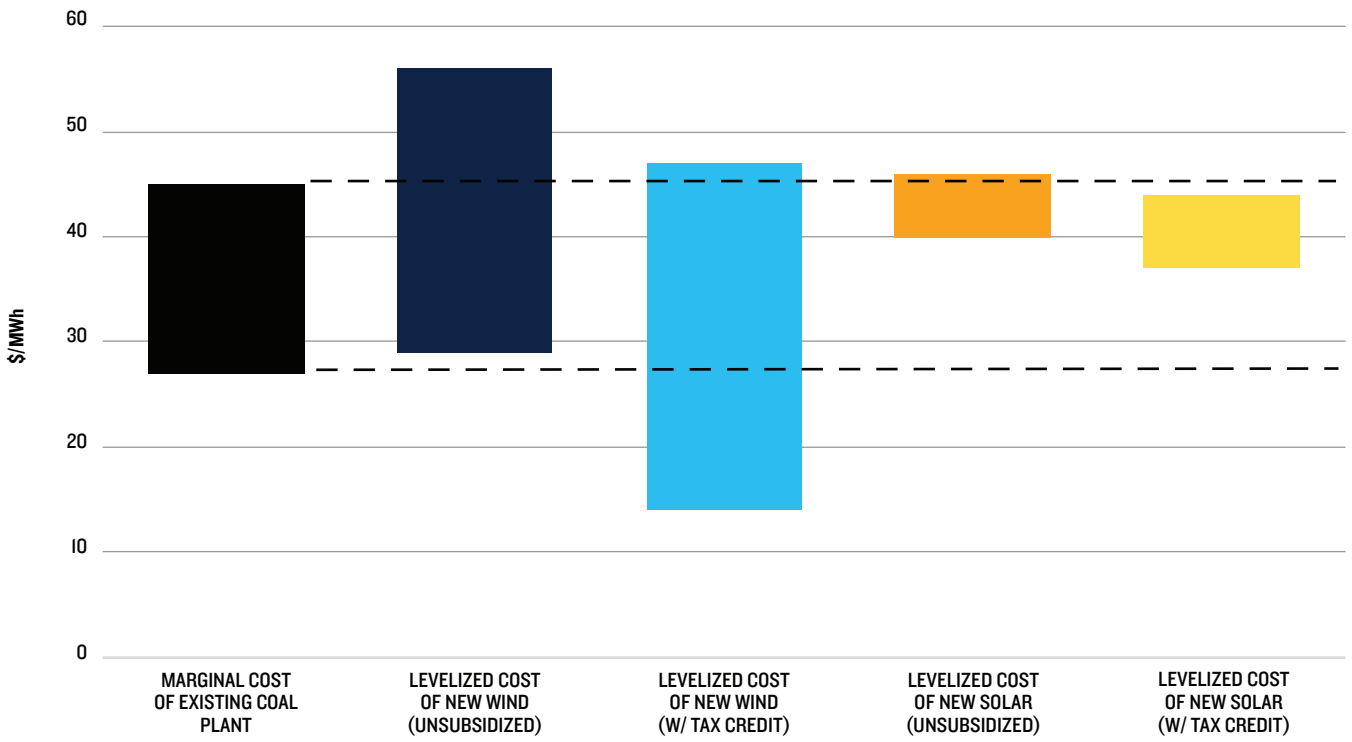


FIGURE 7: LEVELIZED COST OF NEW ENERGY TECHNOLOGIES IN THE UNITED STATES



As clean technologies achieve economies of scale, the costs of wind and solar energy continue to plummet. In the past year alone, the cost of generation from onshore wind, offshore wind, and solar photovoltaics fell by 10, 24, and 18 percent, respectively.[62] For the first time, leading financial firms have begun to highlight a growing truth across the United States: Building a new wind or solar farm is often cheaper than running an existing coal plant (see Figure 7).[63]

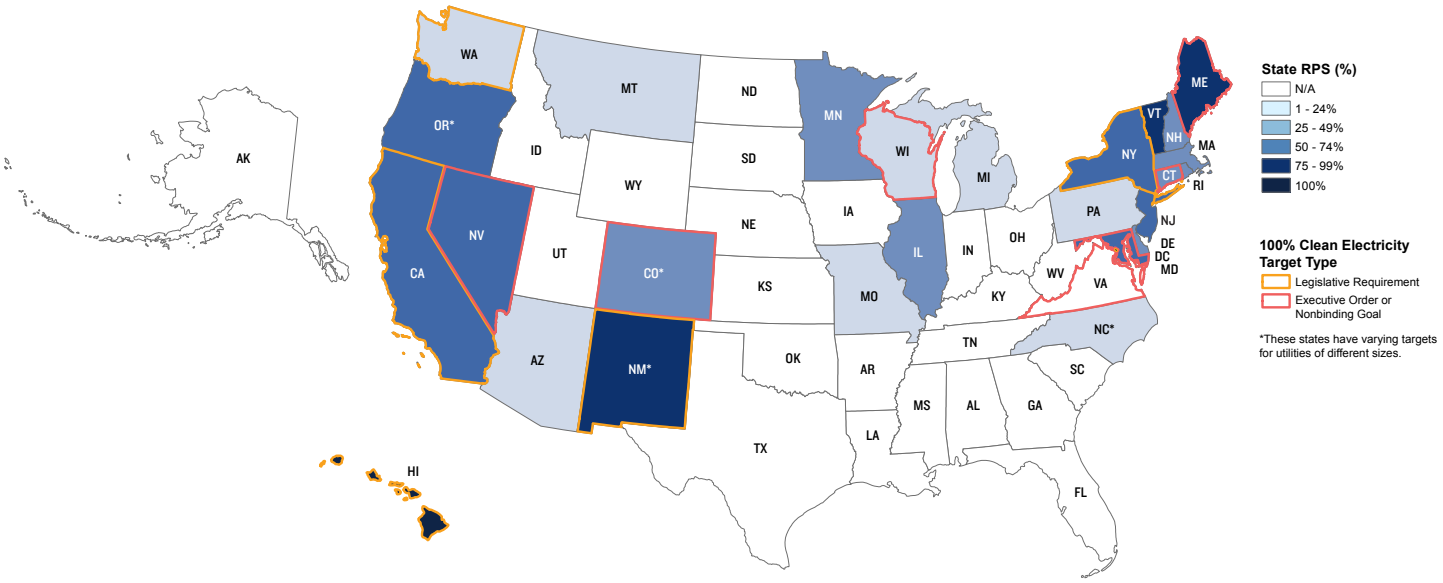
This finding shouldn't be a surprise. U.S. utilities have repeatedly found that moving toward renewable energy (with batteries, demand response, and energy efficiency to help integrate these resources onto the grid reliably) is the best path for them, their customers, and the environment. As renewable energy has become an economic winner—and as supporting technologies such as battery storage have advanced—what is and is not economically achievable has radically changed.

At the end of 2018, Xcel Energy, one of the largest electric utilities in the United States (covering parts of Colorado, New Mexico, Texas, Minnesota, Michigan, North Dakota, South Dakota, and Wisconsin), made a historic commitment to become 100 percent carbon-free by 2050.[64] This was the first voluntary commitment for any investor-owned utility in the nation. Idaho Power, Avista, Green Mountain Power, Duke Energy, DTE, and Madison Gas & Electric have now all joined Xcel and voluntarily committed to achieving carbon-free status, with individual target dates between 2025 and 2050.[65]

Among the states, last fall California passed SB 100, which requires its utilities to achieve carbon-free status by 2045. This followed Hawaii's enactment in 2016 of a target to reach 100 percent renewable energy by 2045 (the state's utilities are currently on track to achieve it five years early).[66] And the momentum continues to grow. As of mid-2019, Maine, New Mexico, New York, Puerto Rico, Washington, and the District of Columbia had all passed legislation committing to carbon-free electricity by the 2040s.[67] New York's landmark climate bill, passed in July 2019, includes commitments to achieve economy-wide net-zero carbon emissions by 2050, in addition to power-sector targets.[68]

In total, these state and utility 100 percent clean energy commitments cover 44.5 million U.S. homes and businesses—equal to about a quarter of all U.S. households—and nearly 24 percent of all electricity consumed in the country.[69] This is a remarkable and rapid change: At the start of 2018, only Hawaii–which accounts for just 0.2 percent of U.S. electricity sales—had a 100 percent clean commitment. Just since the fall of 2018, six states plus Washington, D.C., and Puerto Rico and five investor-owned utilities joined the 100 percent carbon-free movement, providing clear signs that a transition to carbon-free energy is environmentally necessary, economically smart, and politically feasible. Two other states, Nevada and Maryland, passed new renewable energy portfolio standards in 2018, committing to generate

FIGURE 8: MAP OF STATE RENEWABLE PORTFOLIO STANDARDS AND 100 PERCENT CARBON-FREE (OR CLEAN ELECTRICITY) COMMITMENTS



Source: Sophia Ptacek, NRDC

50 percent of electricity from renewable energy by 2030 and including longer-term goals (though not requirements) of 100 percent clean energy by 2050 (see Figure 8).[70]

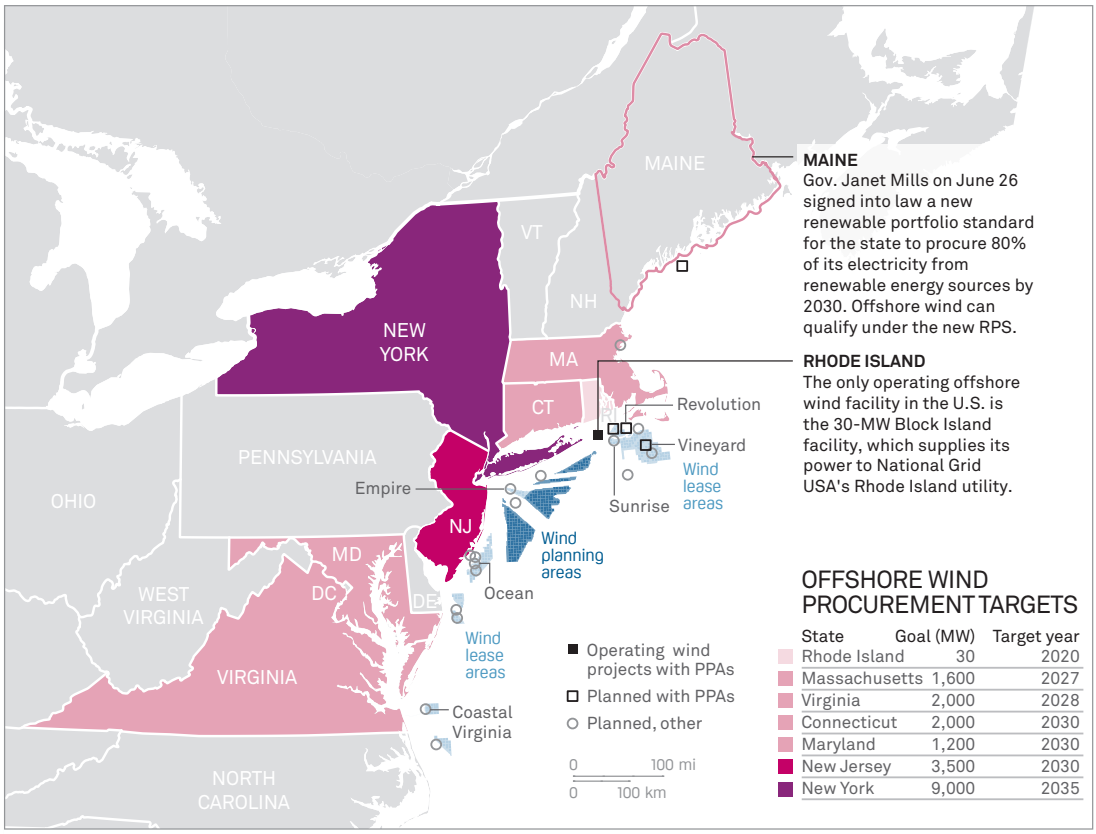
Many of these state targets also include carve-outs that will incentivize and require utilities and other project developers to invest in innovative and emerging technologies. States up and down the East Coast, for example, are investing in offshore wind. New York increased its offshore wind goal to 9,000 MW by 2035 (for reference, the whole country currently has just 30 MW of operating offshore wind projects).[71] In 2018 New Jersey passed a law requiring 3,500 MW of offshore wind by 2030; Massachusetts (which already had a target of 1,600 MW by 2027) will pursue another 1,600 MW by 2035.[72] Connecticut and Maryland added new offshore wind commitments in 2019, calling for 2,000 MW and 1,200 MW, respectively. Projects in the offshore wind pipeline are poised to contribute almost 26,000 MW—nearly 80 percent of which is driven by state offshore wind commitments, as shown in Figure 9.[73]

Massachusetts also announced the winners of its first offshore wind project solicitation last year, shocking energy analysts with the low price for electricity sold to utilities: 6.5 cents per kilowatt-hour (kWh) over a 20-year contract.[74] This price is about half the cost of the most recent winning offshore wind bid, in Maryland in 2017 (at 13.1 cents per kWh) and about a fourth of the first (and only) offshore wind project currently operating in the United States (at 24 cents per kWh).[75]

Individual companies have also greatly increased commitments to renewable and clean energy. In the U.S. and around the globe, corporations more than doubled the amount of renewable power purchase agreements (PPAs) signed between 2017 and 2018, as shown in Figure 10. Companies bought more than 13 gigawatts (GW) of solar and wind power in 2018.[76] U.S. businesses bought nearly two-thirds of this amount—enough to power every home in Maryland for a year. It may be another record-breaking year in 2019, with U.S. corporate purchases already nearing 6 GW as of June 2019.[77] And 191 large corporations have now committed to transitioning to 100 percent renewable electricity—including Walmart, Apple, Coca-Cola, General Motors, Google, Starbucks, and Procter & Gamble.[78] Renewable energy contracts and PPAs will be important tools to meet these lofty targets over the next few decades.

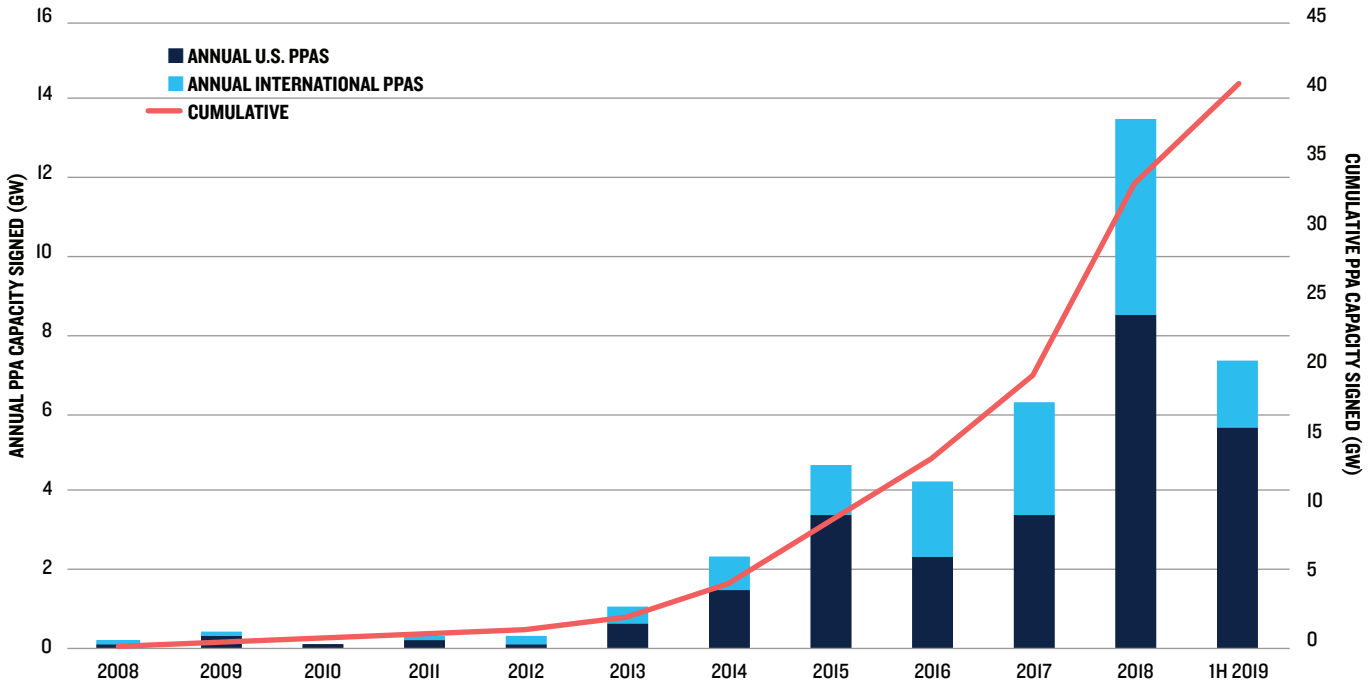
FIGURE 9: OFFSHORE WIND DEVELOPMENT ALONG THE EASTERN SEABOARD

U.S. East Coast states to add more than 19,000 MW of offshore wind by 2035



Map compiled Aug. 21, 2019.
PPA = power purchase agreement
Source: S&P Global Platts; S&P Global Market Intelligence; Bureau of Ocean Energy Management; NYSERDA

FIGURE 10: HISTORICAL CORPORATE RENEWABLE PURCHASES THROUGH POWER PURCHASE AGREEMENTS (PPAS)



FOSSIL FUELS

For a decade the United States has been the world's top producer of gas, and in 2018 it became the largest producer of oil as well, overtaking Saudi Arabia and Russia. Domestic production reached record highs in 2018 (and is unfortunately expected to continue to grow in 2019) as a result of horizontal drilling and hydraulic fracturing, or fracking. In this process, water, sand, and chemicals are injected at high pressure into shale and other so-called tight rocks to fracture the rocks and release the gas or oil trapped inside. This process has greatly altered the U.S. energy system over the past decade, making gas and oil seem plentiful and cheap. However, while fracking keeps fossil fuel prices relatively low, it comes with severe environmental, societal, and public health costs. Gas and oil production activities harm our communities and the environment—contaminating air and drinking water, ruining landscapes, causing earthquakes, harming human health and cultural resources, and contributing to climate change.

Natural (Fossil) Gas

The United States has seen a troubling rush to gas in the past decade: In 2018, for the first time in five years, more natural gas plants were built than renewable energy facilities. There are now more polluting natural gas combined cycle (NGCC) plants than coal-fired plants in the United States.[79] More than 60 percent of all new power plants built in 2018 were gas-fueled, with about 19 GW of new gas-fired capacity coming online (see Figure 11). These new gas-fired facilities, which use gas and steam to generate electricity, will emit about 52 million tons of carbon pollution annually, equivalent to the pollution from all of Arizona's power plants each year.[80] More than half of all new U.S. gas plants were built in just four eastern states: Pennsylvania, Maryland, Virginia, and Florida, with more than a quarter in Pennsylvania alone.[81]

FIGURE 11: CHANGES IN U.S. POWER CAPACITY

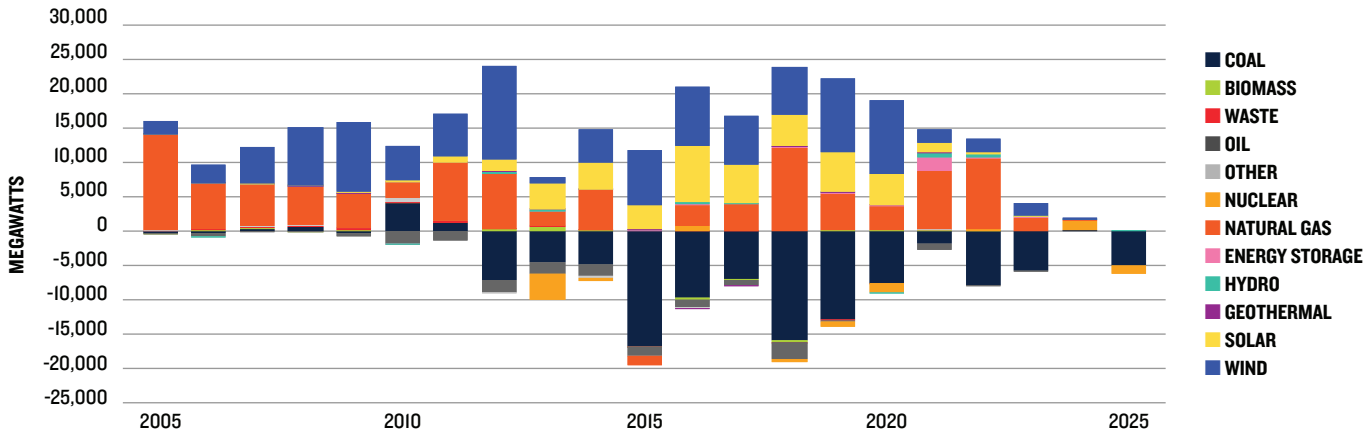
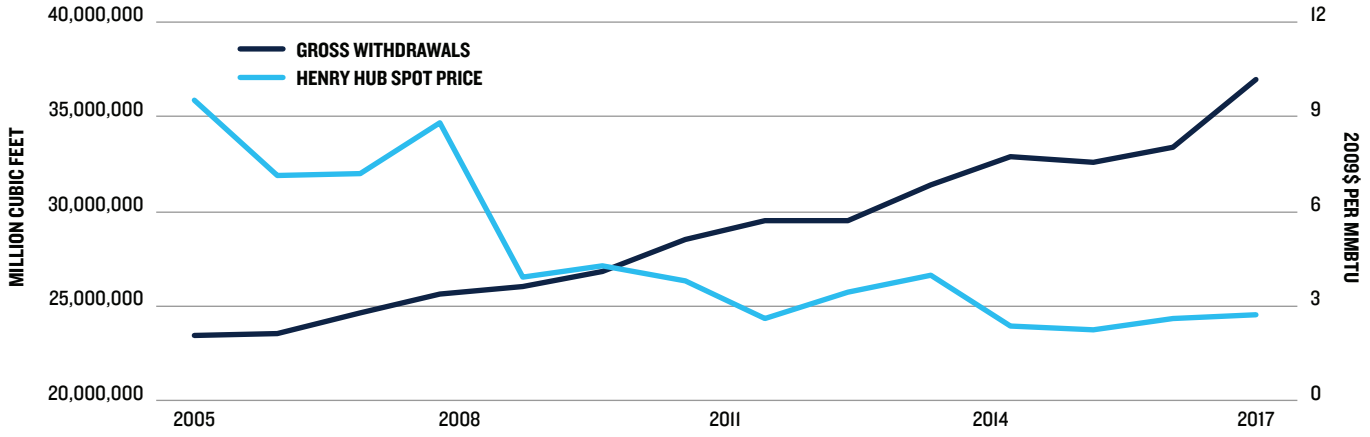


FIGURE 12: DOMESTIC SUPPLY AND PRICES OF NATURAL GAS, 2005–2018



Gas production in the United States grew by 10 billion cubic feet per day (bcf/d) in 2018, the largest year-over-year increase on record, and reached the highest monthly levels ever recorded in December 2018.[82] However, domestic gas supplies have grown faster than domestic demand, resulting in slumping prices, as shown in Figure 12. Gas plants built in 2018 (and those planned to be built by 2022) represent more than $160 billion in capital investment, much of which may be "stranded" (i.e., deemed uneconomic and unnecessary) in the coming decades due to both economics and climate needs.[83] Many relatively new NGCC plants are already getting pushed out of the market: Nearly one in seven newer (less than 20 years old) NGCC plants are rarely used, according to an S&P Global Market Intelligence analysis.[84] To protect its investments, the gas industry is developing massive, long-lived (40 to 60 years) gas infrastructure projects—such as new liquefied natural gas (LNG) export terminals, pipelines, chemical manufacturing facilities, and power plants—that will help them find new markets for the fast-growing supply of gas.[85] The United States has already begun to export progressively more gas, becoming in 2017 a net exporter for the first time in nearly 60 years. In 2018 exports increased by 14 percent from 2017 levels.[86]

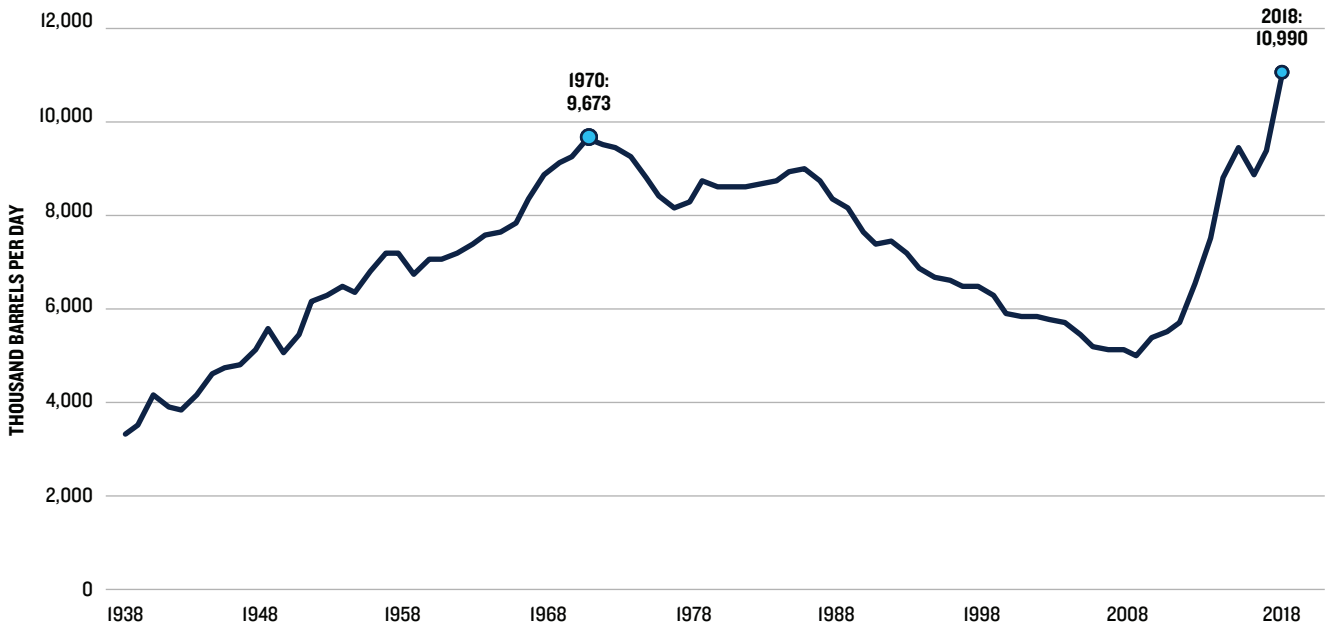
Even as fossil gas becomes cheaper and more available, our growing dependence on and investments in this resource are not compatible with the looming climate crisis. Minimizing investments in new polluting gas infrastructure is crucial if we want to meet our long-term climate goals.[87] Luckily, several cities and states are actively working to combat new gas infrastructure by transitioning to cleaner resources and reducing the risk of stranded assets. Berkeley, California, for example, recently passed the first U.S. municipal ordinance banning natural gas hookups in new low-rise buildings starting in January 2020. The measure is spreading to other cities across California, like San Jose, and around 50 other municipalities are currently considering their own versions of such a law.[88] In Indiana, New Hampshire, and Arizona, regulators recently rejected utility plans to build new gas power plants, citing concerns about the potential for stranded assets, whether new capacity was needed, or if new gas plants could undermine the effectiveness of future state energy plans.[89]

While the fossil fuel industry has looked to gas as a way to decrease carbon pollution relative to coal and oil, gas is not a climate solution. It may be the least-polluting fossil fuel, but it still emits significant amounts of carbon and methane (a potent greenhouse gas) during production, transportation, and transmission. In fact, despite a near-record number of coal plant closures in 2018, new NGCC plants and gas infrastructure led to an increase in overall power-related carbon emissions last year (1.4 percent year-over-year).[90] Better options, such as energy efficiency, renewables, renewable-supporting storage, and clean electrification, now exist at costs just as low as, or even lower than, new gas plant investments.

Oil

In 2018, U.S. oil production surpassed the previous production record, set in 1970 (Figure 13); as mentioned earlier, this made the United States the world's largest producer of oil.[91,92] As with gas, this increase is due in part to new developments in fracking technology. Most of the recent growth in domestic oil production has come from tight oil fields—where fracking processes are used to extract both oil and so-called associated gas—in the Southwest and Great Plains.[93] Like gas, this growing domestic supply of oil has implications not only for the cost and flow of oil, but for the climate and public health.

FIGURE 13: U.S. CRUDE OIL PRODUCTION, 1940–2018



At the end of 2018, the United States briefly became a net exporter of oil for the first time in 75 years.[94] The federal government expects America to become a net exporter of oil (on an annual basis) in 2020 and to remain a net exporter for at least the next two decades.[95] However, this finding does not mean that the U.S. is less dependent on foreign oil: the United States still imports about 45 percent of all oil consumed by U.S. consumers (or about 17 quads of oil annually).[96] While *net* imports have been falling, this is a product of increasing exports of U.S. oil. More than 60 percent of all oil extracted in the U.S. is exported to other countries.[97]

Coal

Coal generation continues to decline as cleaner alternatives like renewables and energy efficiency offer utilities, industry, and consumers cheaper options to meet the nation's energy needs. Across the entire U.S. economy, coal consumption in 2018 was at its lowest levels since 1979, even though electricity use (which accounts for almost all the coal consumed in the United States) has significantly increased in the past three to four decades.[98] In 2018 the U.S. power sector burned less coal than at any time since 1984, with coal providing just 27.4 percent of total U.S. power—the lowest percentage on record (dating back to 1949).[99,100] By contrast, until 2012 coal had always made up at least 40 percent of all U.S. power generation (and more than half as recently as 2003).

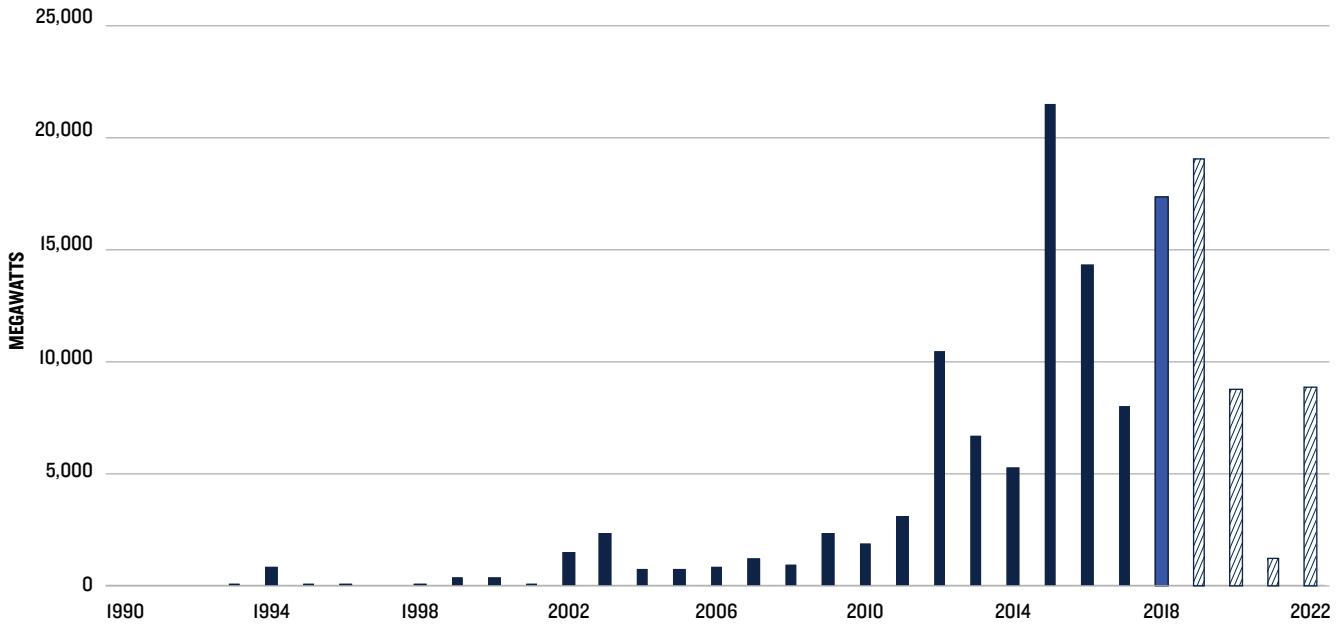
Coal plants were retired at near-record levels in 2018, second only to 2015 when the EPA's Mercury and Air Toxics Standards, or MATS, went into effect, as shown in Figure 14. (MATS required power plants to install technologies that would limit emissions of the toxic air pollutants, such as mercury and arsenic, that are created from burning coal or oil to create electricity.)[101,102] Around 16 GW of coal power capacity was retired in the United States in 2018, and the last decade saw the retirement of 79.5 GW of coal—equal to about one-third of all coal capacity online. The recent retirements and the expected closings over the next year are not driven by federal regulations but by market forces; state policies; and business, utility, and state interest in clean energy.[103]

In response to the deteriorating economics of both coal and nuclear power generation in the face of lower-cost gas and renewables, some states have passed measures intended to prop up or subsidize these older, expensive technologies. Ohio passed 2019 legislation providing financial support for the state's nuclear fleet (see below) and a set of aging coal plants.[104] The legislation also reduced the state's renewable portfolio standard and eliminated energy efficiency requirements (though utilities can still voluntarily pursue energy efficiency). Ohio's regressive energy policy represents one of the biggest steps backward of the past decade**.** By bailing out not only ailing nuclear plants but also dirty coal, and by repealing rather than strengthening clean energy policies, Ohio's move differs significantly from prior subsidy efforts. Fortunately, no other state has shown any interest in following Ohio's dubious lead.

Nuclear Energy

Low wholesale power prices and growing maintenance costs have put increased pressure on America's aging nuclear fleet, resulting in a number of retirement announcements over the past few years. In the fall of 2018, Oyster Creek, New Jersey's oldest nuclear plant, officially closed.[105] In the same year, New Jersey passed a nuclear bill providing up to $300 million in annual subsidies to the state's two remaining nuclear plants, Salem and Hope

FIGURE 14: ANNUAL U.S. COAL RETIREMENTS



Creek, for the next decade.[106] Ohio's financial package for its coal and nuclear plants includes up to $150 million annually for the state's two nuclear plants, Davis-Besse and Perry, from 2021 through 2027.[107] Without subsidies keeping them afloat, two other nuclear plants retired this year: Pilgrim in Massachusetts in May 2019, and Three Mile Island in Pennsylvania in September 2019. Three Mile Island's owner, Exelon, initially sought support from Pennsylvania policymakers to keep the plant open. A bill was introduced in the spring of 2019 in the General Assembly to direct $500 million in annual subsidies to Three Mile Island and the state's four other nuclear plants, but the legislation stalled.[108]

Federal efforts to bail out the nation's coal and nuclear plants have not advanced under the Trump administration, although news reports indicate it is still pursuing options—to prop up these facilities.

CONCLUSION

The U.S. energy trends of 2018 highlight both the opportunities and the challenges facing the nation: Coal is in decline, electric vehicles and grid energy storage are emerging as cleaner mainstream options, and renewables are on the rise—but so are gas and oil.

While progress has been uneven, the country is still transitioning toward clean energy as economics and local action drive investment. Economy-wide, coal use was 47 percent less in 2018 than the DOE projected 10 years ago. Wind and solar capacity are more than four-fold higher than projected. As the country has reduced its dependence on coal and increased the amount of clean, renewable energy power installed, we have seen carbon pollution come in well below projected levels. 2018 carbon emissions were 17 percent lower than projected across the entire U.S. economy. DOE's gas and oil projections have also proven false, though the changes in these metrics are much more troubling. Gas use was 27 percent higher than projected, while domestic oil production was almost 70 percent higher than the DOE anticipated a decade ago.

The falling costs of renewable, efficient, and electric technologies are allowing more Americans to take part in the clean energy revolution. However, this transition is not happening as quickly as it must to address the climate crisis. Climate change reports over the past year underscore the ever-stronger and more urgent environmental and economic rationale for energy efficiency and renewable energy.

As noted in last year's report, the clean energy transition has come at little or no cost to everyday Americans. Household spending on electricity (as a percentage of total spending) has dropped to some of the lowest levels on record. In 2018 U.S. households spent just 1.35 percent of their income on electricity.[109] In the 1980s, by contrast, households spent about 2.2 percent of their income on electricity.[110] The numbers are even more striking when we consider all energy expenses, including both electricity and natural gas. In 2018 U.S. households spent half as much on these energy expenses (as a percentage of total spending) as they did in the early 1980s (1.7 percent versus a high of 3.5 percent in 1982 and 1983).[111] And as noted in the table above, the average electricity price is 17 percent lower than DOE projected it would be—projections that anticipated we would be much more reliant on coal, and with much less wind and solar power operating.

Not only has the United States made progress on clean energy in the past few years, helping reduce both pollution and energy spending, new state and local policies passed since the beginning of 2018 have set ambitious clean energy targets for the coming years. More than 200 million Americans now live in a state that has adopted a statewide greenhouse gas emissions reduction target; almost a quarter of U.S. households are located in a state or utility territory that has committed to becoming 100 percent carbon-free (for at least the power sector) by or before midcentury. These actions will drive the clean energy revolution, even in the face of federal obstacles and the increasing availability of cheap gas and oil, and will support the continued transition toward a cleaner, more efficient, and safer climate future.

METRIC	WHAT WE THOUGHT THE U.S. WOULD LOOK LIKE IN 2018 (10 YEARS AGO)	WHAT THE U.S. ACTUALLY LOOKED LIKE IN 2018	% DIFFERENCE
Total Coal Use (quads)	25.3	13.3	-47%
Total Gas Use (quads)	24.3	31.0	27%
Total Consumption (quads)	109.5	101.3	-8%
Oil Production (quads)	13.5	22.8	69%
Wind & Solar Capacity (GW)	33.2	143.9	334%
Residential Price for Electricity (2018$ cents per kwh)	12.8	10.6	-17%
Total Carbon Pollution (MMT)	6,350	5,274	-17%
Carbon Emissions per GDP (metric ton per million 2012$)	312.9	281.4	-10%

Endnotes

1 Valérie Masson-Delmotte, ed., *Special Report: Global Warming of 1.5 °C*, World Meteorological Organization, 2018, https://www.ipcc.ch/sr15/.

2 Andrew Freedman, "2018's Global Heat Wave Is So Pervasive It's Surprising Scientists," *Axios*, July 27, 2018, https://www.axios.com/global-heat-wave-stuns-scientists-as-records-fall-4cad71d2-8567-411e-a3f6-0febaa19a847.html. Irina Ivanova and Jonathan Berr, "Summer's Record-High Temperatures Threaten to Scorch the Economy," CBS News, July 19, 2019, https://www.cbsnews.com/news/heat-wave-2019-summers-record-high-temperatures-scorch-the-broader-economy/. Harmeet Kaur, "Scientists Bid Farewell to the First Icelandic Glacier Lost to Climate Change. If More Melt, It Can Be Disastrous," CNN, August 18, 2019, https://www.cnn.com/2019/08/18/health/glaciers-melting-climate-change-trnd/index.html.

3 Andrew Revkin, "Most Americans Now Worry About Climate Change—and Want to Fix It," *National Geographic,* January 23, 2019, https://www.nationalgeographic.com/environment/2019/01/climate-change-awareness-polls-show-rising-concern-for-global-warming/.

4 Damian Carrington, "'Brutal News': Global Carbon Emissions Jump to All-Time High in 2018," *The Guardian*, December 5, 2018, https://www.theguardian.com/environment/2018/dec/05/brutal-news-global-carbon-emissions-jump-to-all-time-high-in-2018. EIA, "Section 11: Environment," *Monthly Energy Review,* August 2019, https://www.eia.gov/totalenergy/data/monthly/pdf/sec11.pdf.

5 Climate Mayors, "407 US Climate Mayors Commit to Adopt, Honor and Uphold Paris Climate Agreement Goals," June 2018, http://climatemayors.org/actions/paris-climate-agreement/.

6 ACEEE, *The 2019 City Clean Energy Scorecard*, July 24, 2019, https://aceee.org/local-policy/city-scorecard. Sierra Club, "100% Commitments in Cities, Counties, & States," https://www.sierraclub.org/ready-for-100/commitments (accessed September 6, 2018).

7 In CO_2-equivalent terms. U.S. Environmental Protection Agency (hereinafter EPA), "Overview of Greenhouse Gases," last updated April 14, 2018, https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

8 EIA, "Section 11: Environment."

9 Carrington, "'Brutal News.'"

10 United Nations Framework Convention on Climate Change, "The Paris Agreement," https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (accessed September 2, 2019). Vignesh Gowrishankar and Amanda Levin, *America's Clean Energy Frontier: A Pathway to a Safer Climate Future*, NRDC, September 2017, https://www.nrdc.org/sites/default/files/americas-clean-energy-frontier-report.pdf.

11 Masson-Delmotte, *Global Warming of 1.5 °C*.

12 Jonathan Watts, "We Have 12 Years to Limit Climate Change Catastrophe, Warns UN," *The Guardian*, October 8, 2018, https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report.

13 Masson-Delmotte, *Global Warming of 1.5 °C*.

14 Sheryl Carter and David B. Goldstein, "Energy Efficiency Leads Climate Fight at Lowest Cost, Impact," NRDC Expert Blog, September 20, 2017, https://www.nrdc.org/experts/sheryl-carter/energy-efficiency-leads-climate-fight-lowest-cost-impact.

15 International Energy Agency, "Energy Efficiency Is the Cornerstone for Building a Secure and Sustainable Energy System," October 19, 2018, https://www.iea.org/newsroom/news/2018/october/energy-efficiency-is-the-answer-for-building-a-secure-and-sustainable-energy-syst.html.

16 ACEEE, "Low-Income Programs," https://aceee.org/topics/low-income-programs (accessed September 6, 2018).

17 ACEEE, "The Impact of Federal Energy Efficiency Programs," February 2018, https://aceee.org/sites/default/files/pdf/fact-sheet/impact-federal-ee-programs.pdf.

18 Lauren Urbanek, "The $2 Trillion Success Story: Energy Efficiency Standards," NRDC Expert Blog, February 2019, https://www.nrdc.org/sites/default/files/energy-efficiency-standards-success-story-fs.pdf.

19 Scott B. Harris and John A. Hodges, "DOE Proposes to Amend Efficiency Rulemaking Procedures," Harris, Wiltshire & Grannis LLP, February 19, 2019, https://www.hwglaw.com/doe-proposes-to-amend-efficiency-rulemaking-procedures/.

20 Patterson Clark, "13 Tactics for Obstructing Energy Efficiency," *Politico Pro Datapoint*, August 5, 2019. Subscription required for full report.

21 Sheryl Carter, "Efficiency Saving Energy When We Need It Most—and Cheaply," NRDC Expert Blog, April 19, 2019, https://www.nrdc.org/experts/sheryl-carter/efficiency-saving-energy-when-we-need-it-most-and-cheaply. Appliance Standards Awareness Project, "Missed DOE Deadlines Mounting," updated June 2019, https://appliance-standards.org/sites/default/files/Missed_deadlines_as_of_June_2019.pdf.

22 National Association of State Energy Officials and Energy Futures Initiative, *The 2019 U.S. Energy and Employment Report*, 2019, https://www.usenergyjobs.org/.

23 Ibid.

24 E2, *Clean Jobs America 2019*.

25 Pierre Delforge, "CA Building Code Takes Big Step Toward Net-Zero Energy," NRDC Expert Blog, May 9, 2018, https://www.nrdc.org/experts/pierre-delforge/ca-building-code-takes-big-step-toward-net-zero-energy.

26 Ed Osann, "New CA Lawn Sprinkler Standards = Huge Water & Energy Savings," NRDC Expert Blog, August 14, 2019, https://www.nrdc.org/experts/ed-osann/ca-sets-standards-new-lawn-sprinklers-curb-waste.

27 Lauren Urbanek, "State Efficiency Standards Are Good For Everyone," NRDC Expert Blog, May 22, 2019, https://www.nrdc.org/experts/lauren-urbanek/more-states-ever-are-pursuing-state-standards.

28 Lauren Urbanek, "The Year in Energy Savings, 2018," NRDC Expert Blog, December 18, 2018, https://www.nrdc.org/experts/lauren-urbanek/year-energy-savings-2018.

29 ACEEE, "New York," *State and Local Policy Database*, June 2018, https://database.aceee.org/state/new-york.

30 Ribeiro et al., *The 2019 City Clean Energy Scorecard*.

31 Jon Banister, "Half of D.C.'s Buildings Could Require Upgrades Under New Climate Law," *BisNow Washington D.C.,* January 14, 2019, https://www.bisnow.com/washington-dc/news/sustainability/half-of-dcs-buildings-could-require-upgrades-under-new-climate-law-96705.

32 ACEEE, *2019 State Energy Efficiency Scorecard*, October 2019, https://aceee.org/research-report/u1908.

33 EIA, "Sales to Ultimate Customers (Megawatthours) by State by Sector by Provider, 1990-2018," October 2019, https://www.eia.gov/electricity/data/state/.

34 Laura Goldberg and Lamisa Chowdhury, "Ameren Offers Biggest Energy Efficiency Plan in MO History," NRDC Expert Blog, December 5, 2018, https://www.nrdc.org/experts/laura-goldberg/ameren-offers-biggest-energy-efficiency-plan-mo-history.

35 Frank Jossi, "Deal to Close Minnesota Coal Plants Includes 'Historic' Efficiency Push," *Energy News Network*, June 24, 2019, https://energynews.us/2019/06/24/midwest/deal-to-close-minnesota-coal-plants-includes-historic-efficiency-push/.

36 Jeff St. John, "Xcel Energy Fast-Forwards Minnesota Coal Plant Closures but Extends Nuclear Window," *Greentech Media*, May 20, 2019, https://www.greentechmedia.com/articles/read/xcel-energy-accelerates-coal-plant-closures-to-meet-100-clean-energy-goal#gs.1xa5v5.

37 Robert Walton, "Massachusetts Approves 3-Year Efficiency Plan With First Fuel-Switching Incentives," *Utility Dive*, January 30, 2019, https://www.utilitydive.com/news/massachusetts-approves-3-year-efficiency-plan-with-first-fuel-switching-inc/547237/.

38 Ralph Cavanagh, "Clean Energy Progress in America's Electric Sector in 2018," NRDC Expert Blog, December 6, 2018, https://www.nrdc.org/experts/ralph-cavanagh/clean-energy-progress-americas-electric-sector-2018-0. Wood Mackenzie, *Regulatory Evolution for a Future Electric Grid: State of Performance-Based Ratemaking in the U.S.*, June 13, 2019, https://www.woodmac.com/our-expertise/focus/Power--Renewables/regulatory-evolution-performancebasedratemaking/?utm_source=gtmarticle&utm_medium=web&utm_campaign=wmpr_pbrenerknol19.

39 Trevor Houser, Hannah Pitt, and Hannah Hess, *Final US Emissions Estimates for 2018*, Rhodium Group, May 31, 2019, https://rhg.com/research/final-us-emissions-estimates-for-2018/.

40 Coral Davenport, "Trump Administration Unveils Its Plan to Relax Car Pollution Rules," *New York Times,* August 2, 2018, https://www.nytimes.com/2018/08/02/climate/trump-auto-emissions-california.html.

41 Luke Tonachel and Ben Longstreth, "Illegal Car Standards Rollback Built on Faulty Reasoning," NRDC Expert Blog, October 25, 2018, https://www.nrdc.org/experts/luke-tonachel/illegal-cars-standards-rollback-built-faulty-reasoning.

42 Mike Colias, "Auto Makers Agree to Stricter California Tailpipe-Emissions Standards," *Wall Street Journal*, July 29, 2019, https://www.wsj.com/articles/auto-makers-agree-to-stricter-california-tailpipe-emissions-standards-11564074757.

43 Steven Loveday, *December 2018 U.S. Plug-In EV Sales Report Card, InsideEVs*, January 5, 2019, https://insideevs.com/news/341824/december-2018-us-plug-in-ev-sales-report-card/. Bloomberg New Energy Finance (hereinafter BNEF), *Electric Vehicle Outlook 2019*, May 15, 2019. Subscription required for full report.

44 Alex Davies, "Now on Used Car Lots: Great Electric Vehicles for Cheap," *Wired*, August 5, 2019, https://www.wired.com/story/now-used-car-lot-great-electric-vehicles-cheap/.

45 Andre Haddad, "Why Car Sharing Is Giving Electric Vehicle Usage a Jolt," Turo, April 22, 2019, https://blog.turo.com/insights/why-car-sharing-is-giving-electric-vehicle-usage-a-jolt.

46 Ben Kellison, "4 Takeaways From Amazon's Huge Electric Delivery Van Order," *Greentech Media*, September 26, 2019, https://www.greentechmedia.com/articles/read/4-takeaways-from-amazons-huge-electric-delivery-van-order-with-rivian#gs.6hoyu5.

47 Fred Lambert, "UPS Partners With Startup Thor to Build Two New Electric Trucks," *Electrek*, July 31, 2018, https://electrek.co/2018/07/31/ups-thor-new-electric-trucks/. Taylor Dutch, "UPS Launches New Delivery Program With Electric Bikes," *Bicycling*, October 31, 2018, https://www.bicycling.com/news/a24442179/ups-delivery-program-electric-bikes/.

48 Eric Schmidt, "A Look at Which US Utility Companies Are Running EV Programs," *FleetCarma*, April 11, 2018, https://www.fleetcarma.com/us-utility-companies-running-ev-programs/.

49 Alternative Fuels Data Center (hereinafter AFDC), *Electric Vehicle Charging Outlets by State*, U.S. Department of Energy (hereinafter DOE), September 2019, https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC. Pacific Gas & Electric via Business Wire, "PG&E Launches New Program to Accelerate Electric Vehicle Adoption in Northern and Central California," January 17, 2018, https://www.businesswire.com/news/home/20180117006175/en/PGE-Launches-New-Program-Accelerate-Electric-Vehicle.

50 Joel Espino, "EV Update: PG&E to Deploy EV Charging Stations in Low-Income Communities," Greenlining Institute, January 19, 2018, http://greenlining.org/blog/2018/pge-to-deploy-ev-charging-stations-in-low-income-communities/.

51 Juliana Garcia, "KCP&L Delivers 1,100-Location EV Charging Network, Plans for More," *Kansas City Business Journal*, July 30, 2019, https://www.bizjournals.com/kansascity/news/2019/07/30/kcpl-clean-charge-network-update-future-expansion.html.

52 Peter Valdes-Dapena, "A Game Changer Is Coming for Electric Car Owners," CNN, August 1, 2019, https://www.wptv.com/news/science-tech/a-game-changer-is-coming-for-electric-car-owners. Lia Cattaneo, "Investing in Charging Infrastructure for Plug-In Electric Vehicles," Center for American Progress, July 30, 2018, https://www.americanprogress.org/issues/green/reports/2018/07/30/454084/investing-charging-infrastructure-plug-electric-vehicles/.

53 AFDC, "Alternative Fueling Station Counts by State," DOE, August 2019, https://afdc.energy.gov/stations/states.

54 Associated Press, "California Mandates 100-Percent Zero-Emission Bus Fleet," CBS Los Angeles, December 14, 2018, https://losangeles.cbslocal.com/2018/12/14/california-mandates-100-percent-zero-emission-bus-fleet/.

55 Union of Concerned Scientists, "What Is ZEV?" https://www.ucsusa.org/clean-vehicles/california-and-western-states/what-is-zev (accessed August 30, 2019).

56 Rebecca Bellan, "The Grim State of Electric Vehicle Adoption in the U.S.," *CityLab*, October 15, 2019, https://www.citylab.com/transportation/2018/10/where-americas-charge-towards-electric-vehicles-stands-today/572857/.

57 Katie Pyzyk, "A Look Into Chicago's Electric Vehicle Future," *Utility Dive*, January 30, 2018, https://www.smartcitiesdive.com/news/a-look-into-chicagos-electric-vehicle-future/515810/.

58 Mayor's Office of Communications, "City of Atlanta Passes 'EV Ready' Ordinance Into Law," City of Atlanta, November 21, 2017, https://www.atlantaga.gov/Home/Components/News/News/10258/1338?backlist=/.

59 Jordan David, "Columbus Ohio's Bold Goal: Increasing EV Adoption," *T&D World*, August 5, 2019, https://www.tdworld.com/electrification/columbus-ohio-s-bold-goal-increasing-ev-adoption.

60 EIA, *Electric Power Monthly With Data for December 2018*, February 2019, https://www.eia.gov/electricity/monthly/archive/february2019.pdf.

61 EIA, "Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923)," https://www.eia.gov/electricity/data/state/ (accessed September 13, 2019).

62 BNEF, "Battery Power's Latest Plunge in Costs Threatens Coal, Gas," March 26, 2019, https://about.bnef.com/blog/battery-powers-latest-plunge-costs-threatens-coal-gas/.

63 Lazard, "Levelized Cost of Energy v12," November 2018, https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf.

64 Julia Pyper, "Xcel Energy Commits to 100% Carbon-Free Electricity by 2050," *Greentech Media*, December 4, 2018, https://www.greentechmedia.com/articles/read/xcel-commits-to-100-carbon-free-electricity-by-20501#gs.tfinyj.

65 Idaho Power, "Idaho Power Sets Goal for 100-Percent Clean Energy by 2045," March 26, 2019, https://www.idahopower.com/news/idaho-power-sets-goal-for-100-percent-clean-energy-by-2045/. Catherine Morehouse, "PNM, Avista Commit to Carbon-Free Goals on Heels of State Mandates," *Utility Dive*, April 23, 2019, https://www.utilitydive.com/news/pnm-avista-commit-to-carbon-free-goals-on-heels-of-state-mandates/553240/. Green Mountain Power, "GMP Launches Vision to Have 100% Renewable Energy by 2030," April 13, 2019, https://greenmountainpower.com/news/gmp-launches-vision-to-have-100-renewable-energy-by-2030/. Chris Hubbuch, "MGE Targets Carbon-Neutral Electricity by 2050; Madison Utility Says New Technology Will Be Needed," *Wisconsin State Journal,* May 14, 2019, https://madison.com/wsj/news/local/environment/mge-targets-carbon-neutral-electricity-by-madison-utility-says-new/article_d1a688a5-9330-57e4-b2c6-f3f7930c2321.html. Christian Roselund, "One More State, Two More Utilities Pledge 100% Clean Power," *pv magazine,* April 23, 2019, https://pv-magazine-usa.com/2019/04/23/one-more-state-two-more-utilities-pledge-100-clean-power/.

66 Christian Roselund, "What California's 100% Clean Energy Mandate Means for the United States," *pv magazine,* September 10, 2018, https://pv-magazine-usa.com/2018/09/10/breaking-sb-100-signed-in-california/. Hawaiian Electric, "Regulators Accept Hawaiian Electric Companies' Plan to Reach 100% Renewable Energy," press release, July 17, 2017, https://www.hawaiianelectric.com/regulators-accept-hawaiian-electric-companies-plan-to-reach-100-renewable-energy.

67 Kevin Robinson-Avila, "PNM to Be Carbon Free Five Years Sooner," *Albuquerque Journal*, April 22, 2019, https://www.abqjournal.com/1305833/pnm-to-be-carbon-free-five-years-sooner.html. Gavin Bade, "Puerto Rico Governor Signs 100% Renewable Energy Mandate," *Utility Dive,* April 12, 2019, https://www.utilitydive.com/news/puerto-rico-governor-signs-100-renewable-energy-mandate/552614/. Catherine Morehouse, "Senators Target 50% National Renewable Energy Standard by 2035, Zero-Carbon by 2050," *Utility Dive*, June 27, 2019, https://www.utilitydive.com/news/senators-target-50-national-renewable-energy-standard-by-2035-zero-carbon/557722/.

68 Press Office of Governor Andrew M. Cuomo, "Governor Cuomo Announces Green New Deal Included in 2019 Executive Budget," New York State, press release, January 17, 2019, https://www.governor.ny.gov/news/governor-cuomo-announces-green-new-deal-included-2019-executive-budget. David Roberts, "New York Just Passed the Most Ambitious Climate Target in the Country," *Vox*, July 22, 2019, https://www.vox.com/energy-and-environment/2019/6/20/18691058/new-york-green-new-deal-climate-change-cuomo.

69 EIA, "Electricity: Form EIA-861M, Data for 2018," https://www.eia.gov/electricity/data/eia861m/ (accessed September 2, 2019).

70 Robert Walton, "New Jersey Charts Path to 100% Clean Energy by 2050, With 2 GW of Storage by 2030," *Utility Dive*, June 12, 2019, https://www.utilitydive.com/news/new-jersey-charts-path-to-100-clean-energy-by-2050-with-2-gw-storage-by-2/556649/.

71 Roberts, "New York Just Passed the Most Ambitious Climate Target."

72 American Wind Energy Association, *U.S. Offshore Wind Industry Status Update,* September 2018, https://www.awea.org/Awea/media/About-AWEA/U-S-Offshore-Wind-Fact-Sheet-September-2018_2.pdf.

73 Walter Musial et al., *2018 Offshore Wind Technologies Market Report*, DOE, August 2019, https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Offshore%20Wind%20Market%20Report.pdf.

74 Massachusetts Department of Public Utilities, "Department of Public Utilities Approves Offshore Wind Energy Contracts," Commonwealth of Massachusetts, press release, April 16, 2019, https://www.mass.gov/news/department-of-public-utilities-approves-offshore-wind-energy-contracts. Levelized in 2017 US dollars. Julia Pyper, "First Large US Offshore Wind Project Sets Record-Low Price Starting at $74 per MWh," *Greentech Media*, August 1, 2018, https://www.greentechmedia.com/articles/read/first-large-us-offshore-wind-project-sets-record-low-price-starting-at-74#gs.w5aapa.

75 Ibid. Phil McKenna, "America's First Offshore Wind Energy Makes Landfall in Rhode Island," *InsideClimate News*, May 1, 2017, https://insideclimatenews.org/news/28042017/block-island-wind-farm-deepwater-wind-renewable-energy-climate-change.

76 Julia Gheorghiu, "Corporate Clean Energy PPAs Doubled to 13 GW in 2018: BNEF," *Utility Dive,* January 29, 2019, https://www.utilitydive.com/news/corporate-clean-energy-ppas-doubled-to-13-gw-in-2018-bnef/547013/.

77 Andrew Lee, "Corporate Renewable Energy Set for Record 2019: BloombergNEF," *Recharge News*, August 12, 2019, https://www.rechargenews.com/transition/1835967/corporate-renewable-energy-set-for-record-2019-bloombergnef.

78 RE100, "Companies," http://there100.org/companies (accessed September 2, 2019).

79 EIA, "More Than 60% of Electric Generating Capacity Installed in 2018 Was Fueled by Natural Gas," *Today in Energy*, March 11, 2019, https://www.eia.gov/todayinenergy/detail.php?id=38632.

80 EPA, *Air Markets Program Data,* https://ampd.epa.gov/ampd/ (accessed September 2, 2019).

81 Mark Szybist, "Pennsylvania's Gas Power Problem, Part 1: The Build-Out," NRDC Expert Blog, May 10, 2019, https://www.nrdc.org/experts/mark-szybist/pennsylvanias-gas-power-problem.

82 EIA, "U.S. Natural Gas Production Hit a New Record High in 2018," *Today in Energy*, March 14, 2019, https://www.eia.gov/todayinenergy/detail.php?id=38692.

83 Mark Dyson, Grant Glazer, and Charles Teplin, *Prospects for Gas Pipelines in the Era of Clean Energy*, Rocky Mountain Institute, September 9, 2019, https://rmi.org/insight/clean-energy-portfolios-pipelines-and-plants/.

84 Stephanie Tsao, "1-in-7 Newer Combined-Cycle Plants Are Little-Used, Analysis Finds," *S&P Global Market Intelligence*, July 29, 2019. Subscription required.

85 Bluegold Research, "Natural Gas Market Overview: Record Supply Vs. Record Demand," Seeking Alpha, August 9, 2019, https://seekingalpha.com/article/4284088-natural-gas-market-overview-record-supply-vs-record-demand.

86 EIA, "U.S. Natural Gas Production."

87 Gowrishankar and Levin, *America's Clean Energy Frontier*.

88 Phil McKenna, "Following Berkeley's Natural Gas Ban, More California Cities Look to All-Electric Future," *InsideClimate News*, July 23, 2019, https://insideclimatenews.org/news/23072019/berkeley-natural-gas-ban-california-cities-incentive-all-electric-building-construction-future.

89 Gavin Bade, "Arizona Extends Gas Plant Moratorium, Punts on PURPA Reforms," *Utility Dive*, February 11, 2019, https://www.utilitydive.com/news/arizona-extends-gas-plant-moratorium-punts-on-purpa-reforms/548072/. Gavin Bade, "Indiana Regulators Reject Vectren Gas Plant Over Stranded Asset Concerns," *Utility Dive*, April 25, 2019, https://www.utilitydive.com/news/indiana-regulators-reject-vectren-gas-plant-over-stranded-asset-concerns/553456/. Alex Kuffner, "No on Burrillville Power Plant: Regulators Say Need Wasn't Proven," *Providence Journal,* June 20, 2019, https://www.providencejournal.com/news/20190620/no-on-burrillville-power-plant-regulators-say-need-wasnt-proven.

90 EIA, "Section 11: Environment."

91 Javier Blas, "The U.S. Just Became a Net Oil Exporter for the First Time in 75 Years," *Bloomberg*, December 6, 2018, https://www.bloomberg.com/news/articles/2018-12-06/u-s-becomes-a-net-oil-exporter-for-the-first-time-in-75-years.

92 EIA, "The United States Is Expected to Export More Energy Than It Imports by 2020," *Today in Energy,* January 29, 2019, https://www.eia.gov/todayinenergy/detail.php?id=38152.

93 EIA, "Tight Oil Development Will Continue to Drive Future U.S. Crude Oil Production," *Today in Energy,* March 28, 2019, https://www.eia.gov/todayinenergy/detail.php?id=38852.

94 EIA, "Petroleum & Other Liquids: Crude Oil Production," https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_m.htm (accessed September 2, 2019).

95 EIA, "The United States Is Now the Largest Global Crude Oil Producer," *Today in Energy*, September 12, 2018, https://www.eia.gov/todayinenergy/detail.php?id=37053.

96 EIA, "Section 1: Energy Overview," *Monthly Energy Review,* March 2019, https://www.eia.gov/totalenergy/data/monthly/archive/00351903.pdf.

97 Idib.

98 EIA, "Almost All U.S. Coal Production Is Consumed For Electric Power," *Today in Energy*, June 10, 2019, https://www.eia.gov/todayinenergy/detail.php?id=39792.

99 EIA, "Table 6.2: Coal Consumption by Sector," *Monthly Energy Review,* August 2019, https://www.eia.gov/totalenergy/data/monthly/pdf/sec6_4.pdf.

100 EIA, "Electricity Data: Generation and Thermal Output," https://www.eia.gov/electricity/data.php#generation (accessed August 30, 2019).

101 EIA, "More U.S. Coal-Fired Power Plants Are Decommissioning as Retirements Continue," *Today in Energy,* July 26, 2019, https://www.eia.gov/todayinenergy/detail.php?id=40212.

102 EPA, "Basic Information About Mercury and Air Toxics Standards," https://www.epa.gov/mats/basic-information-about-mercury-and-air-toxics-standards (accessed September 8, 2019).

103 Taylor Kuykendall, "Study Claims 74% of US Coal Plants Uneconomic Compared to Local Wind, Solar," *S&P Global Market Intelligence*, March 25, 2019, https://www.spglobal.com/marketintelligence/en/news-insights/trending/Najze2FvzkSz8JjNzWov4A2. Sophia Ptacek and Sheryl Carter, "More Utilities Make Big Commitments to Climate Action," NRDC Expert Blog, March 5, 2019, https://www.nrdc.org/experts/sophia-ptacek/more-utilities-make-big-commitments-climate-action.

104 Jeremy Pelzer, "Nuclear Bailout Bill Passes Ohio Legislature, Signed by Gov. Mike DeWine," *Cleveland.com*, July 23, 2019, https://www.cleveland.com/open/2019/07/nuclear-bailout-bill-passes-ohio-legislature.html.

105 Ian Shearn, "After the Shutdown: Oyster Creek Nuclear Generating Station," *New Jersey Monthly*, January 14, 2019, https://njmonthly.com/articles/politics-public-affairs/after-the-shutdown-oyster-creek-nuclear-generating-station-forked-river/.

106 Andrew Maykuth, "New Jersey Approves $300 Million in Nuclear Subsidies; PSEG Had Threatened to Close Reactors," *Philadelphia Inquirer*, April 18, 2019, https://www.inquirer.com/business/nuclear-subsidy-new-jersey-approved-pseg-shutdown-threat-300-million-20190418.html.

107 David Roberts, "Ohio Just Passed The Worst Energy Bill of the 21st Century," *Vox*, July 27, 2019, https://www.vox.com/energy-and-environment/2019/7/27/8910804/ohio-gop-nuclear-coal-plants-renewables-efficiency-hb6.

108 Marie Cusick, "Three Mile Island Will Close Sept. 30, as Nuclear Rescue Legislation Stalls in Harrisburg," *StateImpact Pennsylvania,* May 8, 2019, https://stateimpact.npr.org/pennsylvania/2019/05/08/three-mile-island-will-close-sept-30-as-nuclear-rescue-legislation-stalls-in-harrisburg/.

109 U.S. Bureau of Economic Analysis, "Table 2.4.5U: Personal Consumption Expenditures by Type of Product," Section 2, https://apps.bea.gov/iTable/iTable.cfm?ReqID=19&step=2#reqid=19&step=2&isuri=1&1921=underlying (accessed September 4, 2019).

110 Ibid.

111 Ibid.